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Safe let-down for airborne supplies

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A crystal clear view with HDTV

Aussie Tiger bares its teeth

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The Defence Science and Technology Organisation (DSTO) is part of the Department of Defence and provides scientific advice and support to the Australian Defence Organisation. DSTO is headed by the Australian Chief Defence Scientist, Dr Roger Lough, and employs about 2100 staff, including some 1300 researchers and engineers. It is one of the two largest research and development organisations in Australia.

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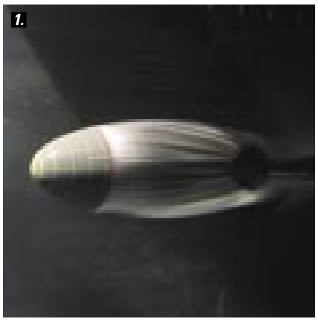
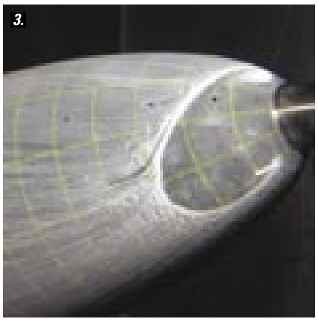
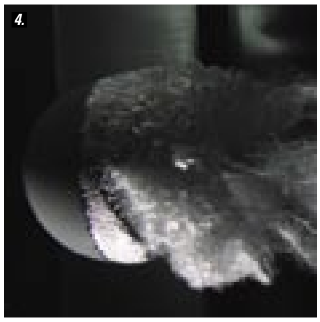
The quest for faster quieter running **in the deep**

DSTO has established a collaborative inter-agency initiative designed to strengthen Australia's capability in experimental and computational hydrodynamics. This collaboration will be important in advising the Australian Defence Force (ADF) on the performance of the Collins Class submarine fleet and to support future underwater platform development.







1. Cavitation about a spheroid.
2. Sting mount with spheroid model attached.
3. Oil film flow about a spheroid.
4. Unsteady cavitation about a sphere.

The Hydrodynamics Group, led by DSTO researcher Brendon Anderson, was formed in 2001, drawing together a number of Australian research organisations in order to develop a better understanding of submarine hydrodynamics and improve the tools for predicting submarine performance.

The organisations currently involved include the Australian Maritime College (AMC), Australian Maritime Hydrodynamics Research Centre, University of Tasmania, Melbourne University, RMIT, and CSIRO.

The research being carried out ranges over many areas of hydrodynamic study: unsteady viscous flows on submerged bodies, prediction of the forces experienced by a manoeuvring submarine, acoustic modelling of noise levels in the wake, the effects of roughness on drag, flow interactions between multiple bodies, and unsteady propeller loading and cavitation.

The work is conducted using computer-based simulations and scale model experiments. One particular problem under study is the effect of cavitation.

Noisy drag-inducing cavitation

Cavitation is a process whereby liquid moving rapidly over a surface, such as a rotating propeller blade or platform control surface, turns from fluid state to gas state due to a drop in the local pressure field below the liquid vapour pressure, giving rise to streams of bubbles that rapidly collapse. This can often result in noise, performance loss and erosion of machinery surfaces.

Research on cavitation is highly significant to ADF submarine operations, given that Australian boats generally have to travel long distances to areas of operational interest, so speed, endurance and stealth are all vital for success.

The Group is carrying out experiments using a water tunnel operated by the AMC in Launceston, Tasmania, named the 'Tom Fink Cavitation Tunnel'. The only one of its kind in Australia, it is a closed, variable pressure, recirculating flow facility. It has a working section of 0.6 by 0.6 by 2.6 metres in size, is capable of flow speeds up to 12 metres per second, and can be pressurised up to 400 kPa. It is used for the study of flow around ship hulls and underwater vehicles as well as general flow applications.

"The research here will give the hydrodynamics team an accurate picture of the physics needed to provide input on Navy requirements," says Brendon Anderson. "It allows us to validate our computational models and use them with confidence."

The Group investigates

Investigations at the AMC include a study of cavitation and other two-phase flows (liquid and gas phase), turbulence and hydro-acoustics that affect the performance of a submarine.

An examination of these factors allows predictions of drag, manoeuvring and signature performance data to be determined for various hull-forms and appendages.

The Group has recently provided advice regarding the impact of design on the hydrodynamic performance of the Collins Class submarines and several off-board systems to the Navy's Submarine Force Element Group, Defence Materiel Organisation and the ASC, formerly known as the Australian Submarine Corporation.

Fatigue testing allows Hawk to go safely aloft

The Hawk Mk. 127 Lead-In Fighter, currently in service with the RAAF, is undergoing fatigue testing in DSTO's Fishermans Bend facilities to establish the airframe endurance limits.

The RAAF acquired its 33 Hawk Mk. 127 aircraft for pilot training in October 2000. The Hawk aircraft were manufactured by BAE SYSTEMS in the UK, with 21 of the fleet being assembled by the company at its facility in Williamtown, New South Wales.

Before the purchase was made, an assessment was undertaken to determine whether a full-scale fatigue test of the Mk. 127 aircraft was necessary, given that testing had previously been carried out on earlier models of the Hawk.

The assessment determined that new tests were essential to provide specific information on RAAF operational usage of the Australian version of the aircraft.

These additional tests were intended to minimise the possibility of fatigue-related damage and potentially increase the operational life of the RAAF fleet by establishing the areas that may be prone to such damage so that proactive repair and maintenance programs can be put in place.

Monitoring the health of the fleet

DSTO researcher Tim Bussell explains the relationship between the fatigue testing program and Hawk operations.

"The Hawk Mk.127 fleet has been operational since 2000 under an interim flight clearance that allows for such activity prior to full-scale testing."

"The test team will reach 15,000 equivalent flying hours – which equates to approximately 3,000 actual safe flying hours – before the operational aircraft get to that point. This is considered a requirement in ensuring the continued safe operation of the fleet."

"The test involves loads, based on both computational modelling and instrumentation from actual flights, being applied to the test article. More than half the test period will be taken up with inspections to detect any damage that may appear as a result of the airframe being 'flown' in the rig to specific RAAF projected fatigue spectra. The full-scale fatigue test is expected to continue until 2012."

Once the decision was made to proceed with a comprehensive fatigue test, DSTO and BAE SYSTEMS entered a commercial business agreement to conduct the test in Australia. Personnel from both organisations are participating in the venture, along with several Australian contractors with a range of backgrounds and expertise.

Making the test rig

The first step towards carrying out the fatigue-testing brief involved the design and construction of the test rig, which was undertaken by BAE SYSTEMS with DSTO support, commencing in May 2002.

Housed in a new test laboratory at DSTO's Fishermans Bend site, the recently completed rig is an eight-metre high, three-level structure. It features several structural innovations: a first level platform two metres off the ground provides sufficient headroom for systems installation within the rig footprint; additional floor area on all levels surrounding the fatigue article allows for ergonomic work practices and equipment distribution; and a removable top deck facilitates the installation and removal of the fatigue article as required.

The main control system was developed by a US company while DSTO provided some background intellectual property to enhance the functionality of the system. The system applies and monitors loads to the test article from 84 hydraulic and 6 pneumatic channels simultaneously. It also includes a fully integrated 1200 channel data acquisition system.

The hydraulic actuators were designed and manufactured in Australia. The valve packs, or Controlled Abort Manifolds, which form part of a fully independent controlled abort unload system, have also been produced in Australia based on a DSTO design.

During rig construction, the test Hawk airframe has been fitted with strain gauges and loading linkages. In addition, several dummy test items have been fitted, including the undercarriage, engine, tailplane, ejection seats and flaps. The test at Fishermans Bend is being complemented by a tailplane (buffet) test being carried out in the UK by BAE SYSTEMS.

The Hawk is the first aircraft to undergo testing in the new facility. The rig became fully operational in September 2005.

1. Hawk Lead-In Fighter.
2. Hawk Lead-In fighter airframe being readied for fatigue testing.
3. Hydraulic load application pads bonded to the Hawk airframe.

2.

Enhancing Australia's fatigue testing capability

DSTO's recently opened state-of-the-art fatigue test facility at Fishermans Bend was named the H.A.Wills Structures and Materials Test Centre, in honour of former Australian Defence scientist, Arthur Wills, who pioneered the theory and practice of aircraft structural testing now followed by aircraft manufacturers worldwide.

Over the past 50 years, DSTO has established an enviable reputation as a world leader in fatigue-testing work on defence platforms, most recently winning the prestigious Von Karman award for its international program to assess the fatigue life of the FA-18 A/B Hornet aircraft.

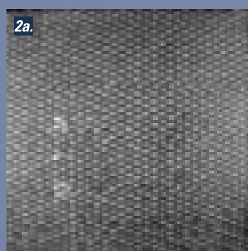
For the RAAF and BAE SYSTEMS, the opportunity to tap into DSTO's expertise was one of the key reasons to conduct the full-scale test of the Hawk Mk 127 in Australia, while for DSTO, the project provides an opportunity to maintain the organisation's fatigue testing capability.

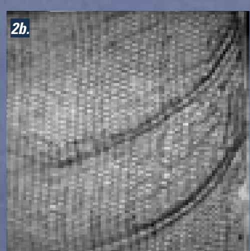
The commercial business agreement between DSTO and BAE SYSTEMS benefits both organisations through the sharing of expertise and the creation of intellectual property. BAE SYSTEMS is able to use such knowledge in future commercial enterprises, while DSTO has the opportunity to further its expertise in the area of fatigue testing. In addition, more than $10 million worth of contracted work will flow to Australian industry.

3.

Safe let-down
for airborne supplies

After a series of incidents in which air-dropped goods and equipment were damaged during Australian Defence Force (ADF) operations last year, DSTO was requested to investigate the dynamic crush characteristics of the energy dissipating material (EDM) being used to cushion the ground impact of air-dropped goods.





US Air Force C-130 Hercules aircraft dropping equipment. (Original DoD photo taken by Tech. Sgt. Justin D. Pyle, US Air Force.)

This study was seen by senior command of the ADF to be critical to the ADF's airborne operational capability, and a response was required within three months of the request.

DSTO researcher Dave Cannon explains the significance of the work. "A damaged air drop package due to faulty EDM or other reasons could have very serious consequences for troops in a 'hot zone' or behind enemy lines where timely re-supply may be difficult or impossible, not to mention the costs involved."

"Correct performance of the material, properly crushing on impact, is also vital for speed of operations under these conditions by automatically loosening the tie-down straps on packages to allow for easy removal, and enabling vehicles to be immediately driven away," he says.

The type of goods requiring impact-cushioning range from large objects such as Land Rovers and field artillery to smaller packages such as supplies of food, water and munitions. EDM is mostly used in multiple layers. A field gun, ammunition and supporting equipment form a complex load requiring layers of EDM of varying area at particular locations on the air drop package.

EDM construction

EDM is made of a paper product known as Kraft Board in grades of 120 grams or 150 grams per square metre. It consists of a paper honeycomb core 75 mm thick, faced on both sides with the paper. It is designed to support a minimum static spread load of 19,500 kilograms per square metre.

To perform correctly, the material should comply with dynamic crush stress requirements by collapsing to at least 70% of its original thickness. During collapse, the tubular honeycomb cells burst to release the entrapped air. The energy dissipated in the process averts a massive deceleration or bounce that could damage the package contents.

In determining EDM performance capabilities, other factors that need to be considered include cell size and structure, moisture content, water absorptiveness and water resistance of the adhesive used in manufacture.

The evenness of the honeycomb cells is also very important since areas of increased density lead to hard spots and unpredictable performance.

The EDM used by the ADF in recent years has been obtained from the US, but the product is now being manufactured in Australia on a trial basis.

The EDM test facility

A dynamic crush stress test facility was established at the DSTO Fishermans Bend site to undertake the investigation. An accelerometer and a non-contact laser based measurement system were used to record impact information. During setting up and trialling of the system, 5000 frames of high-speed video footage were shot to capture the process of collapse for every 1/100th of a second.

The outcome of the trials was that the US-sourced EDM was shown to have an unacceptably high dynamic crush stress, meaning that the jolt experienced by the payload would be too strong for survivability.

Testing of trial samples of the Australian-made EDM has shown that while acceptable crush properties are achievable, the results also indicate that honeycomb core distribution can be a problem. DSTO has successfully used a thermal imaging process known as 'flash thermography' to reveal the honeycomb structure of fully faced panels, and has discussed with the Australian manufacture the possibility of using the technique for production line inspection to identify any unacceptable EDM panels.

The supply of EDM by a local manufacturer is expected to result in significant cost savings to the ADF.

1. Dynamic crush stress test apparatus at DSTO's Fishermans Bend site.
2. Thermography images of EDM panels:
a, showing regular core spacing; b, showing abnormalities in core spacing.
3. Army Land Rover being air-dropped with EDM packaging.
4. EDM honeycomb core and facing materials.
5 Humvee prepared for airdrop. (US DoD photo by Staff Sgt. Carlisle P. Fountain, US Air Force.)

Soft option with huge potential in fibre optics

DSTO is undertaking collaborative research with the University of Adelaide in the recently formed Centre of Expertise in Photonics to explore the exciting possibilities offered by new-generation optical fibre technology.

The Centre, under the direction of Professor Tanya Monro, was formed by DSTO under a strategic alliance with the University to conduct research in the design and manufacture of optical fibres with soft glass and polymers – materials that hold great promise to deliver vast advances in capability for defence and other applications.

Unlike optical fibres made of hard silica glass, soft glasses are capable of transmitting light in new wavelengths, the mid-infrared range, which is a frequency band of particular interest for various Defence applications.

Furthermore, they can be more readily infused or 'doped' with a range of elements that enhance their performance in various ways, changing them from a passive carrier of light to active components like in-fibre light amplifiers and lasers.

Another major advantage these materials offer over hard silica is that they melt at lower temperatures, which enables the use of die casting and extrusion techniques to create optical fibres with novel structures involving arrays of holes running along the fibre. This gives them extraordinary new performance properties.

Hard versus soft glass

Until recently, optical fibres were generally made of high purity silica glass, consisting of a small solid glass core along which the light travelled, and an outer layer or cladding of glass with a lower refractive index that acted to contain the light in the core by total internal reflection.

Although soft glass was known to have desirable optical characteristics as long as thirty years ago, it was not used for optical fibre production because of problems with manufacturing.

"It is significantly more difficult to make the conventional form of fibre using soft glass than it is with silica," explains Professor Monro, "The use of two glass materials requires that both core and cladding have viscosity properties that are similar enough to allow them to be drawn together into a high quality low-loss fibre at the same temperature. It is also necessary to use materials that are chemically compatible, and have the desired refractive index contrast."

"Meanwhile, researchers in the mid 1990s who were investigating new designs for optical fibres, discovered that arrays of holes could be used as the cladding for a fibre. The core of the fibre can either be a solid region of glass surrounded by the cladding air holes, with light contained in the core by refractive index contrast created by the air holes, or the core can consist of air, with light guided by a different mechanism known as the 'photonic bandgap' effect. Using this approach, fibres could be made out of a single material composition."

These designs, known as micro-structured optical fibres, were first created using silica glass by hand-assembly of fine glass tubes to make a 'preform' of about two centimeters in diameter and fifteen centimeters long. The preform was then heated until soft, and drawn into fibres of hair-breadth thickness, with the holes now shrinking to just a few microns in size in a microscopic replication of the original structure.

A giant leap forward in optical fibre technology

After the discovery that arrays of holes could provide the necessary containment for light within a fibre, the way was now open to make optical fibres from soft glass, with a number of significant advantages flowing from this development.

Since soft glass becomes viscous at low temperatures, the preform can be made using extrusion processes by forcing the heated glass under pressure through stainless steel dies, obviating the need for the time-consuming hand-assembly process. This process is much more difficult to apply with hard glass because of the high temperatures required.

Furthermore, using extrusion methods, a much wider range of designs is attainable than the hexagonal arrays that hand-assembled preforms are basically limited to. One such design (produced by extrusion) that confines light very effectively, a three-hole structure with a central core supported by three long fine struts, cannot be produced by the hand stacking process.

Researchers have found that varying the design of the fibre by the number, positioning and size of holes and the size and nature of the core radically varies its performance characteristics. The light can either be confined very tightly within the core to produce new light frequencies as an outcome of phenomena called 'nonlinear effects', used in the development of many new devices, or it can be allowed to spread more widely throughout the fibre cross-section for high power transmission, such as for laser applications, without melting the fibre.

Another advantageous property of micro-structured optical fibres is that they can enable transmission of light in what is known as 'endlessly single mode', meaning that different frequencies of light are transmitted on a single fibre with good beam quality for all wavelengths that the material is transparent. For example, using conventional solid fibres, the

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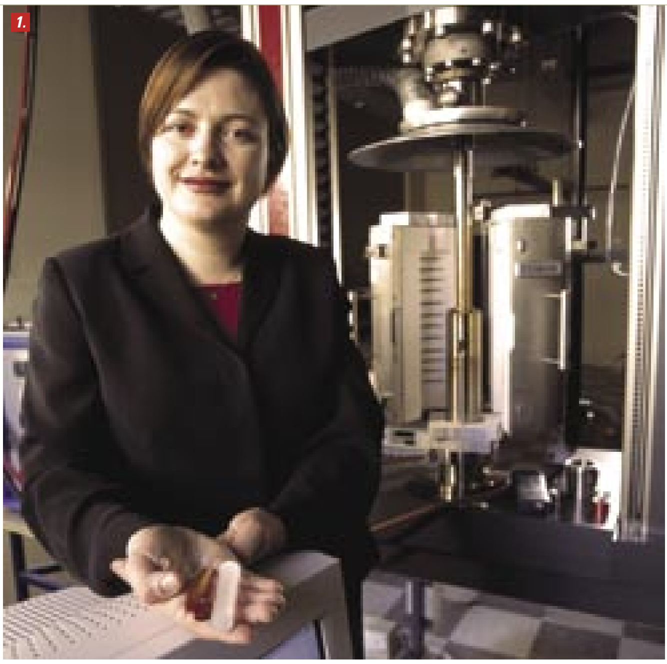

red, blue and green signals for a laser-based video image must be sent on three separate fibres, whereas all three signals can be sent on a single micro-structured fibre.

A plethora of application possibilities

As a key part of its PA-10 project activities, DSTO is developing component technologies for an airborne missile defence system known as a directed infrared countermeasure (DIRCM).

DIRCM provides protection against infrared-guided missile attack by directing a beam of infrared energy at the missile's guidance system, effectively blinding it so that it veers away. The DIRCM unit produces a beam generated by a powerful laser, which, in the original design, was sent via a series of mirrors that steered the light as required.

DSTO researchers are working with the Centre of Expertise for Photonics to develop a micro-structured optical fibre that can withstand the power levels required for distributing the laser beam around the platform in a more practicable way, offering easier alignment and more flexibility.

Other kinds of applications the Centre is investigating include the use of micro-structured optical fibres as sensors to detect chemical and biological materials. By infusing the holes in a fibre with test materials in liquid or gas form, the absorption of light passing along the fibre can reveal the nature of the material being tested.

In addition to sensing what is in the environment, it is envisaged that micro-structured optical fibres can be used to actively change and manipulate materials. Researchers have begun investigations into the use of light to separate and sort proteins, with different wavelengths of light having effects on different size molecules.

Another area of research involves the design and development of new in-fibre photonic devices that exploit nonlinear optical effects to regenerate and switch optical data streams using light, thus eliminating the various interim electronic-to-light conversions and reversions currently required. This research is aimed at increasing the capacity of optical communications systems.

1. Professor Tanya Monro with soft glass preform production equipment.
2. Profiles of soft glass preforms.
3. Preforms and ingots for production of soft glass micro-structured optical fibres.

2.

A strategic alliance between DSTO and University of Adelaide

The Centre of Expertise in Photonics, formed by DSTO and the University of Adelaide with support from the SA Government, began operations early in 2005.

The Centre is located within the School of Chemistry & Physics at the University of Adelaide, and is closely linked with the University's Optics and Photonics group. It collaborates with DSTO on research to develop new classes of optical fibre for Defence applications, and also collaborates with other academic groups as well as industry.

The Centre is currently in the process of establishing a complete suite of design, fabrication and experimental capabilities that will enable new concepts in soft glass fibres to be developed through to reality and real world applications.

The Centre operates under the leadership of Professor Tanya Monro who is recognised as a world-leading researcher in the field of photonics. She completed her PhD at Sydney University in 1998 with a thesis on self-writing waveguides in photosensitive materials, and was awarded the 1998 Bragg Gold Medal for Excellence in Physics for the best PhD thesis by a student from an Australian university.

She then went to work at the Optoelectronics Research Centre (ORC) at the University of Southampton in the UK as a postdoctoral research fellow, holding a Royal Society University Research Fellowship and a permanent research position as a Principal Research Fellow and Reader. During this time, she began working on micro-structured optical fibre research.

In 2004, she was invited to take up the appointment of DSTO Professor in Photonics at the University of Adelaide. She has over 190 publications to her name and holds eight patents.

3.

1-3. Three images taken with the HDTV on board DSTO's ISR testbed Beechcraft 1900C aircraft.
4. DSTO's ISR testbed Beechcraft 1900C aircraft.
5. ISRTB ground station operations during HDTV trial.
6. HDTV on ISR testbed aircraft.
7. HDTV operator on board ISR testbed aircraft.

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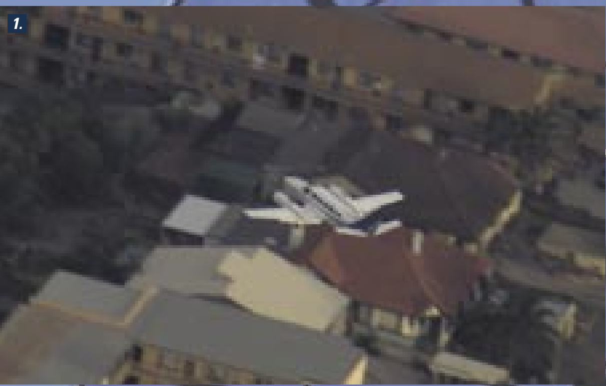

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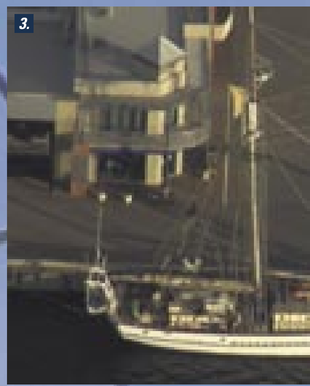

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ISR test bed ground-based data link dish.

A crystal clear view with HDTV


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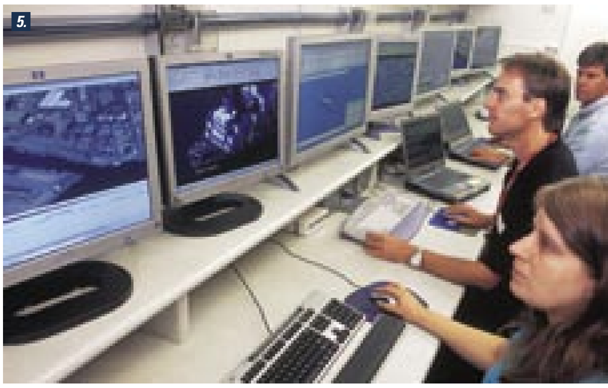
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DSTO's electro-optical surveillance testbed has been fitted with high definition television (HDTV) imaging equipment to examine improvements in the quality of visual material this technology offers and how best to use it.

The research was carried out as part of 'Project Crystal View', a collaborative venture between DSTO and the US National Geospatial Intelligence Agency (NGA).

This project provided support for the integration, evaluation and performance characterisation of an electro-optic high definition digital motion imagery (HDTV) sensor system into DSTO's Intelligence Surveillance and Reconnaissance Testbed.

It was the vastly superior imaging capabilities of HDTV technology that attracted the interest of military researchers. HDTV in fact has its genesis in findings by commercial television researchers that people who watched a wider screen image saw it as more compellingly real than those on other formats.

The advantages of HDTV

DSTO researcher Merrilyn Fiebig explains, "HDTV offers a big improvement on existing television standards such as PAL used in Australia, and NTSC in the US. It presents up to twice as many lines of picture information on a screen, and a wider screen picture in aspect ratios comparable to movie screen widths, with overall image detail of up to ten times that of other formats."

Another advantage of HDTV is that it uses digital technology for transmission. While it began thirty years ago as an analogue system like PAL and NTSC, it has been developed for the world market in recent years on a digital basis. The use of data compression software, such as MPEG-2, which transmits only changes to the picture image, means that sending a digital picture requires only a quarter of the bandwidth for analogue transmission. In the world of commercial television, this allows for additional content services (such as text and additional views) to be provided for a given waveband allocation, or for more transmission licenses to be issued within the spectrum available for television service providers.

Furthermore, a digital signal is less prone to electromagnetic interference than analogue, and can provide a much clearer picture on the screens of even standard definition receivers.

The image scanning systems used by the various kinds of HDTV systems include both 'interlaced' and 'progressive' modes, as used also by analogue systems. In the interlaced mode, only every alternate line on the screen is scanned every 60th of a second so the entire image is refreshed only once every 30th of a second; with the progressive mode, every line is scanned every 60th of a second. While the progressive mode (in use on the ISR Testbed) requires slightly more bandwidth, it provides a better, steadier image without flickering.

The Crystal View trials

During the recent trials, a wide range of activities was carried out to quantify, explore and demonstrate the HDTV technology for military surveillance applications.

According to Fiebig, "Results from the trial clearly demonstrated that HDTV offers a significant improvement in image quality over legacy 'interlaced' video systems such as NTSC."

"This improvement leads to an improved capability to detect, classify and identify targets and activities. It also leads to a much improved ability to conduct later analysis of the data, thereby increasing the intelligence value of the material collected."

Aussie Tiger
bares its teeth

DSTO researchers supported trials in Woomera in May this year for the first test firing of a Hellfire missile from Australia's new Tiger Armed Reconnaissance Helicopter (ARH). The test firing was one of a sequence designed to demonstrate the safe and effective deployment of the laser-guided missile, which has a longer-range capability than those used on European versions of the Tiger.

1.

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The trials were necessitated by decisions made some years ago when the Australian Defence Force (ADF) opted to acquire Eurocopter's Tiger Armed Reconnaissance Helicopter with the recommendation, on advice from DSTO, that it be fitted with a longer-range weapon system for operations in Australian environments.

In the process, the laser-guided Hellfire was selected, requiring changes to the Tiger weapon system.

The background to the choice of the Hellfire, as DSTO researcher Bill Woods explains, is that despite advances in 'fire-and-forget' weapons over recent years, their performance has often been disappointing. This led to a perceived need for the gunner to maintain more effective control, achievable with laser guidance.

"The Hellfire missile, manufactured by Lockheed Martin, locks on to a laser spot that is projected onto the target either by the helicopter gunner, or by suitably equipped ground troops who, in general, have more time to identify concealed enemy positions," he says.

"To provide the ARH with autonomous targeting capability for Hellfire, a laser has been built into and aligned with its roof-mounted electro-optical sight. Australian ground forces are also equipped for remote designation with a lightweight tripod-mounted laser projector (the GLTD) with similar characteristics."

Testing Hellfire

As part of the process for acceptance into service of the Tiger ARH, Australian Aerospace, a subsidiary of Eurocopter that assembles the aircraft in Australia, is required to demonstrate the safe and effective deployment of Hellfire in a number of test scenarios.

A total of nine firing cases are to be demonstrated; three using a captive missile, and six live firings. One of the live firings will use a live warhead.

The cases comprise a variety of launch conditions, such as different altitudes, velocities, sideslip, vertical climb, bank angle, pilot or gunner firing, helmet sight or roof mounted sight, lock-on before or after launch, high or low trajectories, remote or autonomous designation, and simulated building or armoured personnel carrier targets at different ranges. One firing is to take place at night.

The Hellfire Test Campaign is being carried out in two phases by Defence in cooperation with Australian Aerospace. The recently conducted Phase One included the first inert practice missile being launched from an Armed Reconnaissance Helicopter while airborne. Phase Two, expected to be undertaken later in the year, will include the firing of live missiles.

DSTO support for the recent trials

The equipment deployed by DSTO to facilitate the missile launch included two army laser designators (GLTDs) backed up with a DSTO-manufactured designator.

To study parameters such as laser energy, position of laser spot on target, reflectivity of targets, spot stability and atmospheric attenuation, DSTO also deployed a newly developed laser spot measuring camera, a laser receiver and energy monitoring equipment, and two 2-metre square calibrated targets. A frame-grabber recorded the camera image for subsequent analysis of laser spot stability and verification of the missile performance.

The trials were carried out at Woomera Range for safety reasons. The missile has a potential range of up to 12 kilometres and the lasers used have nominal optical hazard distances up to 40 kilometres. As a safeguard, non-essential personnel were excluded from both a circular radius of 12 kilometres from the missile launch point and a 40-kilometre fan-shaped sector in the direction of the laser beams.

This necessitated that the process of remote designator targeting be undertaken via a microwave link from the range control building, and also that the laser spot be monitored and recorded remotely. These stringent conditions, not previously imposed on DSTO trials with laser-guided munitions, required the preparation of new and modified equipment by DSTO.

A large number of practice engagements were performed by the ARH during the May deployment, including a missile launch that made impact with the target.

If the Hellfire missile is accepted for use on the Tiger ARH – the most advanced aircraft of its kind in the world – it will significantly enhance an already formidable Defence capability in terms of Army firepower, protection and mobility.

3.

DSTO's laser-guided weapon research facilities

DSTO has been supporting research on laser weapon systems since the 1980's, well before the Army began acquiring this kind of equipment.

With the recent upsurge in military laser system acquisitions, DSTO's experimental and testing facilities for lasers have been extended by the re-siting and upgrading of its laser range at DSTO Edinburgh. The facility, designed to provide a safe and convenient site for the testing of optical equipment, consists of a laser tower, target cabins located at 700 metres and 1500 metres, a target tower and a crew room.

Another facility at DSTO's Edinburgh site, the Missile Simulation Centre (MSC), is used for testing of missile guidance systems in simulated conditions to enable research on a wide range of operational scenarios. This complements the data obtained by live testing but without the same level of cost. The Centre has a 5-axis motion table on which hardware-in-the-loop simulations can be carried out with infrared and radio-frequency scene generators. (See story Studying the Evolved Sea Sparrow Missile in captivity *in ADS Autumn Issue Volume 13 Number 1, 2005)*

DSTO is now developing a laser scene generator at the MSC specifically for simulating the type of scenes that the Hellfire missile might encounter in ADF operations. In particular, atmospheric effects and the terrain and solar background can be simulated and manipulated, along with possible countermeasures. These capabilities ensure that the ADF can be advised on the optimum tactics for employing the weapon in addition to any potential limitations.

1. Hellfire missile on Tiger ARH used in first Woomera trials.
2. Tiger ARH over Woomera Range.
3. Tiger ARH carrying Hellfire missile.

UC^2 offers new view on **command and control**

DSTO recently issued a theoretical document, *A Dialectic for Network Centric Warfare,* containing new understandings about ways to conduct the command and control aspects of conflict.

The paper, authored by DSTO researchers Dr Dale Lambert and Dr Jason Scholz, has been developed to help the Australian Defence Force (ADF) maintain its capability edge in the present information age.

The position they are promoting, known as Ubiquitous Command and Control, is signified by its authors with the acronym UC^2, which is colloquially rendered as 'you see too' (deliberate pun intended) to emphasise the more inclusive and all-pervasive nature of the decision-making and information flows involved.

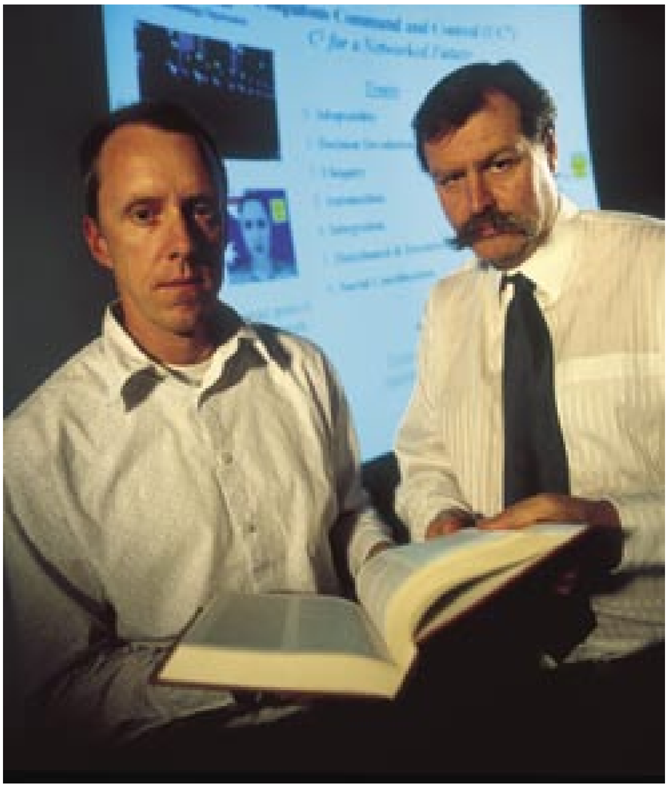
Dr Scholz describes UC^2 as "a significant expansion to the conventional approach to military operations, formulated to take advantage of the benefits on offer from emerging information technology and evolving commercial practices." He says, "It allows current ways of doing business, such as hierarchies, to be retained where they work well, and where they don't, to augment them with whole new modes of operation."

The impetus for UC^2

"In the post-September 11 world, we're facing an expanded realm of conflict, which in turn requires expansion to our notions of cooperation," Dr Scholz explains. "UC^2 is about how to achieve unity in operations without sacrificing diversity of positions on operational issues. Some of the barriers built within mission command and military appreciation processes need to be removed to make this possible. We propose ways to do that."

UC^2 is the outcome of extensive investigations that have vigorously examined the strengths and weaknesses of Network Centric Warfare (NCW) in order to enable effective implementation of the ADF's NCW Roadmap. NCW principles are being applied in Australia and many other countries across all areas of the armed services to allow for greater self-organisation by networking information more widely to increase the tempo, effectiveness and responsiveness of operations at lower risk and cost.

Most advocates in the debate about NCW have sided into two main groupings: the 'Dogmatists' who see NCW as an inevitable success with the more information sharing the better; and the 'Sceptics' who regard NCW as a flawed 'religious excursion'. The interaction between these two sets of ideas, thesis (dogmatists) and antithesis (sceptics), has led to the creation of the UC^2 position, a synthesis that supersedes both, establish Drs Lambert and Scholz in their paper.



Dr Jason Scholz (left) and Dr Dale Lambert.

UC^2 formulations and recommendations

They have formulated their position on UC^2 into nine tenets encapsulated in the key words, 'adaptations', 'decision devolution', 'ubiquity', 'automation', 'integration', 'distributed and decentralised', 'social coordination', 'management levels', and 'UC^2 design'.

Some of the recommendations flowing from their work are: that the efficiency of mission command be improved for networked operations by embracing a broader concept called 'mission agreement'; that the Joint Military Appreciation Plan (JMAP) be replaced in time with a more flexible form called 'Diverse Appreciation' suited to distributed locations and decentralised command intent; that those common operating picture variants based on the use of consistent data and information be replaced by systems designed to communicate agreed situation awareness; and that a legal agreement protocol, which may be implemented in software, be developed to support a broad range of coordination and collaboration that includes self-synchronisation.

The paper by Dr Lambert and Dr Scholz is available online at http://www.dodccrp.org/events/2005/10th/CD/papers/016.pdf and a DVD presentation of this content, featuring illustrations from feature films and documentaries including *Thirteen Days, The Thin Red Line, The Matrix* and *The Fog of War,* is expected to be available by the end of the year for study purposes within Defence.

Air-to-air missile support facility opened at DSTO

A new facility called The Australian ASRAAM Software Support Capability (AASSC) was opened recently at DSTO Edinburgh to develop software loads for the Advanced Short Range Air-to-Air Missile (ASRAAM).

ASRAAM was accepted into service by the RAAF in 2004 for deployment on F/A-18 Hornet aircraft.

The AASSC's primary objective is to enable rapid implementation of new Counter Counter Measure algorithms within Australia as the combat environment changes, but the capability will also allow the development of specific modifications desired by the RAAF.

Like most modern missiles, ASRAAM is software driven and an Australian capability to upgrade the software will enable RAAF to suit its own fleet and operating conditions.

The AASSC is complemented by the ASRAAM Deeper Maintenance Facility located at BAE SYSTEMS Australia premises at Edinburgh Parks in Adelaide. Both facilities are operated by BAE SYSTEMS Australia under sub-contract from MBDA UK, manufacturers of the missile.

F/A -18 Hornets fitted with ASRAAM missile.

New NICTA-DSTO collaboration

At the 2005 ICT Outlook Forum held recently in Sydney, a new collaborative R&D initiative in human system integration was announced between DSTO and National ICT Australia (NICTA).

Known as HxI, this new program is expected to offer significant benefits to DSTO and Defence by bringing together a critical mass of new technologies and researchers to develop advanced human-machine interfaces for evaluation as potential ADF applications.

During the Forum a number of interesting findings were also presented while exploring the theme 'promoting Australia's competitive advantage through ICT'. They included the observation that the nature of ICT innovation is changing.

Reported research shows that 80% of innovation in ICT in Australia takes place in user companies rather than in R&D environments. Furthermore, graduate skills most valued in industry and R&D environments are changing from code-cutting to systems, integration and customer partnering skills.

The ICT Outlook Forum is organised annually by DSTO, CSIRO, NICTA and the Council of ICT Cooperative Research Centres to focus on ICT research and development priorities for Australia.

Qantas support for DSTO research

Qantas Airways has agreed to provide access for DSTO researchers to its facilities at the Qantas Jet Engine Test Cell at Mascot in April 2006 to study the level of partial obscuration on directed infrared countermeasures (DIRCM) that arise in the zone of heat and turbulence caused by jet engine exhaust.

This access will enable DSTO to measure the ability of the DIRCM system to track a warm object through the line of sight of a jet engine plume, and the level of degradation in the outgoing laser beam used to 'blind' an incoming infrared guided missile.

A Defence scholarship awarded to DSTO researcher William Isterling is facilitating studies on laser beam propagation to achieve a more effective countermeasure against missile threats. The outcome of the research may lead to the development of obscuration maps to input to the countermeasures suite operational logic. (For more information, see article *Aircraft countermeasure against missile attack* in ADS Winter Issue Volume 13 Number 2, 2005)

This work is aimed at supporting the installation of DIRCMs onto the Wedgetail and Multi-role Tanker Transport and possible use of DIRCMs on civilian aircraft. DSTO recently invited Dstl in the UK to participate in this activity.

CALENDAR

25 - 26 Oct 2005	Next Generation Threats to Australia Kokoda Foundation Conference National Conference Centre, Canberra http://www.kokodafoundation.org/confer/confer.htm
31 Oct - 2 Nov 2005	Communications, Internet and Information Technology Cambridge, USA Email: calgary@iasted.org
3 - 4 Nov 2005	Safety of Flight Conference Beaumont House Conference Centre Berkshire, United Kingdom http://www.tangentlink.com
7 - 9 Nov 2005	Systems Engineering/Test and Evaluation Conference Carlton Crest Hotel, Brisbane http://www.iceaustralia.com/sete2005/
14 - 16 Nov 2005	Human-Computer Interaction Phoenix, Arizona, USA Email: calgary@iasted.org
15 - 16 Nov 2005	Urban Warfare Asia Pacific Marriot Surfers Paradise Resort, Queensland Tel +65 6720 0620 Fax +65 6720 0621 Email: raja@marcusevanssg.com
5 - 8 Dec 2005	2nd Australian Conference on Artificial Life University of Technology, Sydney http://www.itee.adfa.edu.au/~abbass/acal05/
31 Jan - 2 Feb 2006	Pacific 2006 International Maritime Conference Sydney Convention and Exhibition Centre, Darling Harbour Tel + 61 2 9265 0700 Fax +61 2 9267 5443 http://www.pacific2006imc.com/
31 Jan - 2 Feb 2006	RAN Sea Power Conference 2006 Sydney Convention and Exhibition Centre, Darling Harbour Tel + 61 2 9265 0700 Fax + 61 2 9267 5443 http://www.seapower2006.com/

Front Cover: AC-130 drops a pallet. (Original DoD photo taken by Staff Sgt. Cary Humphries, US Air Force.)

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